Case History

Balancing an over fire air fan (OFA)

by John Kingham
Machinery Diagnostic Services Engineer
Bently Nevada Corporation
Philadelphia, Pennsylvania

Technical literature commonly refers to the fact that 75% of machinery vibration problems exhibit symptoms typical of unbalance or misalignment. It is important that the diagnostician recognize the often subtle difference between the correction of the symptoms and the correction of the problem. If only the symptom is treated, degradation of the machine may ultimately occur in some other form. This article presents a case history of a machine initially believed to be out of balance. Upon close examination of the data, which was collected using a Bently Nevada ADRE® 3 system and the 108 Data Acquisition Unit, a totally different cause of vibration was established and corrected.

During the commissioning of a new trash-to-steam plant, Bently Nevada Corporation personnel helped balance several forced draft (FD) and over fire air (OFA) fans. The OEM's representative had problems with one OFA fan in particular. This unit was a 200 HP fan of overhung, squirrel cage design utilizing rolling element bearings for rotor support (Figure 1).

The common methods of supporting overhung fans generally result in a larger vibration response in the horizontal plane than in the vertical plane. This is generally due to more compliance in the horizontal plane. Overall and 1X filtered data from the temporary XY Bently Nevada Seismoprobes mounted on both of the fan bearings suggested that field balancing was an appropriate action. The relative ease with which balancing could be carried out supported a balancing attempt as well. The bearing closest to the fan, bearing #4, had overall amplitudes of 0.68 in/sec (17.27 mm/sec) peak horizontally, and 1.02 in/sec (25.9 mm/sec) peak vertically. The 1X amplitudes were 0.52 in/s (13.2 mm/sec) peak at 331° and .89 in/sec (22.6 mm/sec) peak at 254°, respectively (Figure 2).

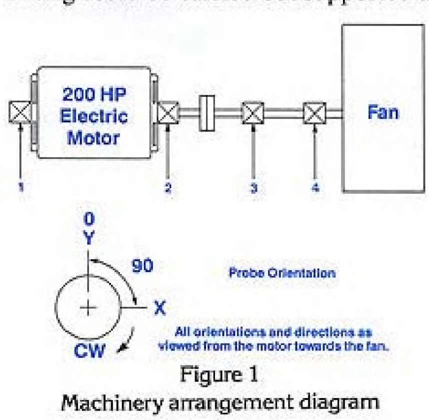

Figure 1
Machinery arrangement diagram

An initial attempt at balancing was made by placing 11 grams of weight at 180° against rotation (AROT) on the inboard wall of the impeller. This weight and location was determined from a review of the Polar plots obtained during a shutdown (Figure 3). These Polar plots also showed the rotor was operating below its first balance resonance. Upon startup, 1X levels were 0.73 in/sec (18.54 mm/sec) peak at 129° and 1.16 in/sec (29.46 mm/sec) peak at 52°. It appeared that we had applied an excessive correction and "pushed" the response vector through zero. Independent calculations, using both the vertical and horizontal response to the calibration weight, indicated that approximately 4.7 grams were needed at 192° (Figure 4).

The next balance attempt used 5 grams at 200° AROT. This yielded ►

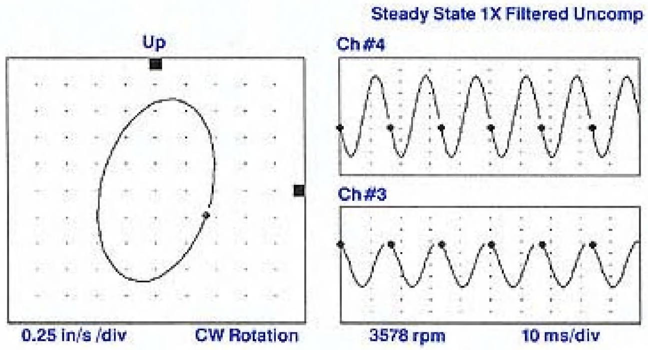

Figure 2
Initial steady state data for Bearing #4

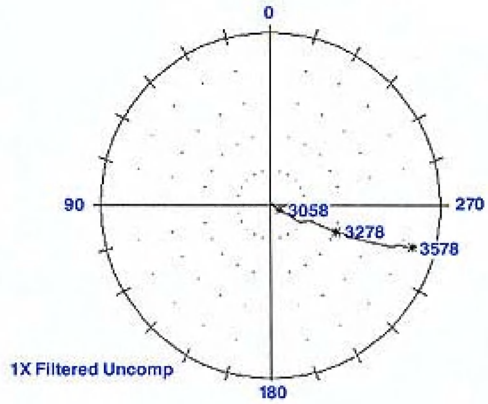

Figure 3
Polar plot of Bearing #4 vertical shutdown

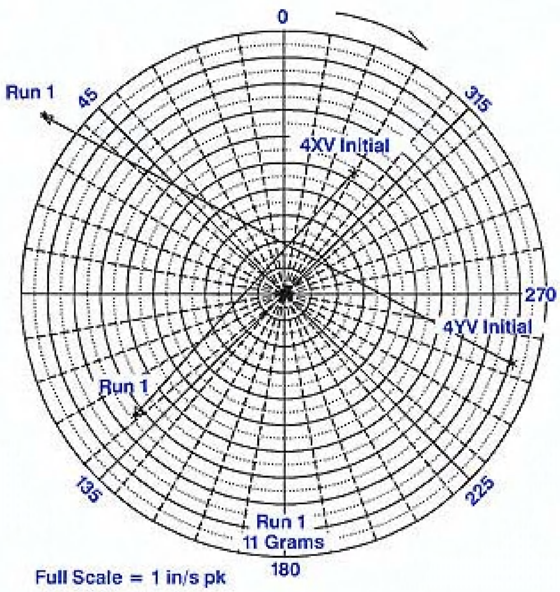

Figure 4
Graphical representation of balance data for Run 1

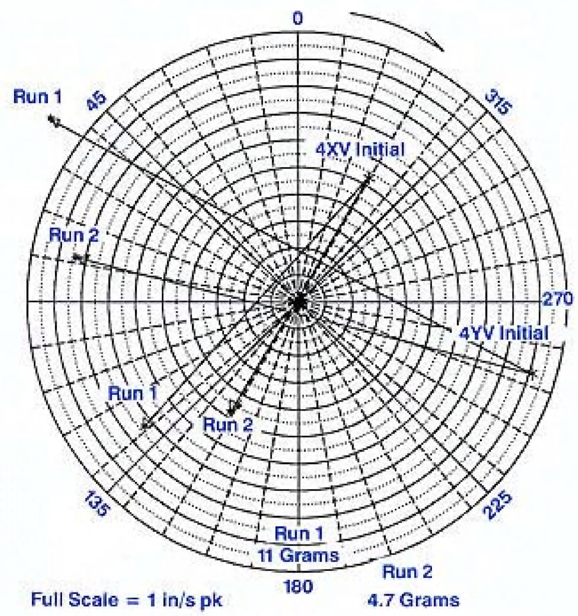

Figure 5
Graphical data after Run 2

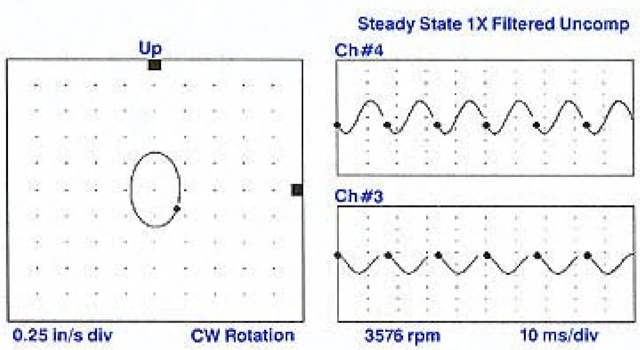

Figure 6
Steady state with 3 mil shim, before final balance

levels of 0.48 in/sec (12.19 mm/sec) peak at 149° and 0.84 in/sec (21.34 mm/sec) peak at 79°. It was clearly evident that the fan, for some unknown reason, was not responding in a linear fashion (Figure 5).

The fan would start up with reasonable vibration levels, but shortly after reaching running speed, vibration levels and phase radically changed, accompanied by an audible difference in vibration. No further attempts to balance the fan were made. At this time, a rub was suspected due to the change in amplitudes and the audible vibration.

What at first appeared to be nonlinearities due to massive unbalance appeared now to be due to a rub situation. The fan was inspected for rubs, but none could be found. Another problem that could have caused these nonlinearities was a looseness in the bearing support system. The #4 bearing cap was removed, and it was determined that about 3 to 5 mils of looseness existed.

A 1-mil feeler gauge was placed in the top of the bearing cap to determine the effects on running speed vibration. The fan was operated and the vibration amplitudes decreased but was still accompanied by an audible vibration change. However, these vibration levels were still excessive.

A 3-mil feeler was then placed into the top of the bearing cap, and the fan ran with a **consistent** 1X reading of approximately .21 and .35 in/sec (5.3 and 8.9 mm/sec) peak (Figure 6). It looked like the problem was corrected.

Although the fan could have been rebalanced at this time, operators decided to wait until a good bearing/pillow block could be installed. The fan bearing and pillow block were replaced, and the fan was then successfully trim balanced by the manufacturer's representative.

Conclusion

The lesson learned from this case history is that, while a situation may appear to be caused by unbalance, care should be taken prior to, and during, any attempted balancing to determine if the state of balance is indeed the root cause or simply a symptom. Experience indicates that balancing is often indicated and often performed, but may not be the root cause of the machine problem.